ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)

June 2001

BUDGET ACTIVITY
2 - APPLIED RESEARCH

PE NUMBER AND TITLE
0602303A - Missile Technology

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	53431	70076	40112	0	0	0	0	0	0	0
214 MISSILE TECHNOLOGY	38566	51209	40112	0	0	0	0	0	0	0
223 AERO-PROPULSION TECHNOLOGY	12409	18867	0	0	0	0	0	0	0	0
340 SWORD	2456	0	0	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification:

PLEASE NOTE: This administration has not addressed FY2003-2007 requirements. All FY 2003-2007 budget estimates included in this book are notional only and subject to change.

This applied research program element investigates advanced technologies for missiles, rockets, and unmanned vehicles for use on the Future Combat Systems (FCS) and the Objective Force. Major technology areas include missile guidance systems, air defense acquisition systems, multi-spectral seekers, high fidelity simulations, missile aerodynamics and structures, and missile propulsion. The overall objectives are to increase the survivability of launch systems; provide greater lethality and effectiveness under adverse battlefield conditions; increase kill probabilities against diverse targets; and provide powerful new simulation and virtual prototyping analysis tools. As Compact Kinetic Energy Missile (CKEM) technologies mature, demonstrations will be conducted under PE 0603313A (Missile and Rocket Advanced Technology). The CKEM program transitions in FY02-03 to the advanced technology demonstration phase. Another effort in this PE is the high-g, low cost, Micro Electro-Mechanical Systems (MEMS) Inertial Measurement Unit (IMU) program. This effort will provide MEMS IMU's for precision guidance of missile and munitions. This program is a collaboration with the Armament Research and Development and Engineering Center. Funding has been increased in FY02-05 and FY07 to complete the design, demonstration, and testing for this effort.

Work in this program element is related to, and fully coordinated with, efforts in PE 0602702E (Tactical Technology), PE 0602602F (Conventional Munitions), PE 0603601F (Conventional Weapons Technology), PE 0601104A (University and Industry Research Centers), PE 0603313A (Missile and Rocket Advanced Technology), PE 0603654A (LOSAT Advanced Concept Technology Demonstration), PE 0602782A (Command, Control and Communications (C3) Technology), PE 0605601A (Army Test Ranges and Facilities). The cited work is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan (AMP) and Project Reliance. The program element contains no duplication with any effort within the Military Departments. Work is performed by the Aviation & Missile Research, Development, and Engineering Center, U.S. Army Aviation and Missile Command, Redstone Arsenal, AL.

B. Program Change Summary	FY 2000	FY 2001	FY 2002	FY 2003
Previous President's Budget (FY2001 PB)	47939	47183	30029	0
Appropriated Value	48392	70683	0	
Adjustments to Appropriated Value	0	0	0	
a. Congressional General Reductions	0	0	0	
b. SBIR / STTR	-963	0	0	
c. Omnibus or Other Above Threshold Reductions	-148	0	0	
d. Below Threshold Reprogramming	3999	0	0	
e. Rescissions	-349	-648	0	
OSD Realignment	2500	0	0	
Adjustments to Budget Years Since FY2001 PB	0	0	10083	
Current Budget Submit (FY 2002/2003 PB)	53431	70035	40112	0

Change Summary Explanation: Funding: FY 2000: a one-year Congressional add was received for:

- Project A340, Short Range Missile Defense with Optimized Radar Distribution (SWORD) (+2500) - This one-year congressional add investigated the technical feasibility of the SWORD interferometric radar.

In FY 2001, one-year Congressional adds were received for:

- Project A214: Low Cost Guidance and Navigation Set (+4500) - This one-year Congressional add completes phase one of the Low Cost Guidance and Navigation set. This effort will complete fabrication of a first generation prototype Global Positioning System/Inertial Measurement Unit (GPS/IMU).

- Project A223: Accelerated Dev/Test Tactical Missile Components (+8000) - This one-year congressional add completes component design and testing of advanced missile components for hypersonic missile airframes.

- Project A223: Aero-Optic Evaluation Center (AOEC) (+3500) - This one-year congressional add upgrades test capabilities of the aero-optics evaluation center and performs aero-thermal, aero-optics, aerodynamics, and aero-acoustics tests at hyper sonic flight conditions.

- Project A223: Enhanced Scramjet Mixing (+1500) - This one-year congressional add completes research of propulsion technology for potentially longer and faster flight of Army missiles.

- Project A223: Future Army Tactical Missile Integration Program (FMTI) (+6000) - This one-year congressional add completes design, integrate and test of components for future hypersonic missile systems.

In FY2002, project A214 was increased to develop a high-g, low cost MEMS IMU (+10083).

In FY2003, project A214 was increased to develop a high-g, low cost MEMS IMU (+10026).

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - APPLIED RESEARCH	**0602303A - Missile Technology**	**214**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
214 MISSILE TECHNOLOGY	38566	51209	40112	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This project focuses on missile and rocket technologies that support lightweight, highly lethal weapons concepts with greatly reduced logistics requirements for the FCS and Objective Force. Major technology areas investigated are missile guidance systems, air defense target acquisition systems; multi-spectral seekers; high fidelity simulations; missile aerodynamics and structures; and missile propulsion. Research objectives are to enhance the survivability of launch systems, provide greater effectiveness under adverse battlefield conditions, increase kill probabilities against diverse targets, and provide powerful new simulation and virtual prototyping analysis tools. The major effort in this project is the CKEM. This missile is a prime candidate to provide overwhelming lethality for the FCS Direct Fire System with increased stowed rounds. The CKEM program schedule has been aligned with the FCS schedule. The funding for this program was increased in FY01 and FY02 to accelerate component testing to ensure that a prototype is ready for insertion into the FCS demonstrator in FY04. As efforts in this project mature, work is transitioned to PE 0603313A (Missile and Rocket Advanced Technology) to support demonstrations of capabilities for CKEM and Common Missile. Another effort in this project is the high-g, low cost, MEMS IMU program. This effort will provide MEMS IMU's for precision guidance of missile and munitions. This is a joint program with the Armament Research and Development and Engineering Center. Funding has been added in FY02-05 and FY07 to complete the design, demonstration, and testing for the MEMS IMU effort. Major contractors are Lockheed Martin, Dallas, TX; MILTEC/Boeing, Huntsville, AL; Raytheon Company, Tucson, AZ; and BAE Systems, Austin, TX. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 13494 - CKEM -Implemented Industry/Government cooperative programs for overall CKEM system engineering, design and analysis, and technology and component maturation. Awarded four (4) Phase I base contracts for system concept definition. Awarded multiple contracts for CKEM component and technology maturation in the areas of high-g guidance components and advanced propulsion.

  - Performed testing to quantify secondary lethality effects and to substantiate a 25% increase in missile lethality with novel penetrators.

FY 2000 Accomplishments (Continued)

- 14320 - Missile guidance systems - tower tested and evaluated automatic target recognition (ATR) hardware/algorithms in realistic battlefield environments to include smoke and countermeasures. Integrated and tested High Quantities Anti-material Submunition (HI-QUAMS) small laser radar (LADAR) seeker brassboard. Matured GPS jamming/spoofing models of inexpensive, small hardware for Army tactical missile application. Matured enhanced guidance link technology for loitering missiles and mini-unmanned aerial vehicles (UAVs). Devised counter-countermeasures for infrared imaging seeker countermeasures.

  - High fidelity system level simulations and aerodynamics - extended the field programmable gate array digital quadrature modulator for increased processor throughput and higher clock rates. Extended the Ka-band radio frequency (RF) front-end processor design of the RF target verification monitor to handle short RF pulses. Implemented parallel processing programmable "model board" software for real-time, dynamic representation of missile seeker input optics and target image sensed scene irregularities.

- 8310 - Smart, stealthy, smokeless missile propulsion and smart structures - fabricated final design of conformal optical dome and corrector elements, integrated with imaging IR seeker and performed imaging and tracking evaluations of conformal optical seeker that will provide the technology to significantly extend the range of tactical missiles. Completed maturation of improved fuel gel for long range, survivable, multi-mission capabilities. Matured and tested hydrogen chloride (HCl)-free propellants for minimum signature propulsion.

  - Focused technology integration - transitioned current Remote Readiness Asset Prognostics/Diagnostics System (RRAPDS) technology to PATRIOT Project Office, finalized functional requirements, and designed specifications for RRAPDS objective system which provides near real-time logistics situational awareness thereby significantly reducing operating and support costs. Developed motor performance requirements, identified turbojet maturation issues, and developed a design to adapt the DARPA Netfires Loitering Attack Munition (LAM) to rotary wing aircraft.

- 2442 - One year Congressional add completed Low Cost Guidance and Navigation Unit specifications for a small, inexpensive, jam-resistant global positioning system (GPS)/inertial navigator for multiple weapon applications including projectiles, missiles, vehicles, and aircraft.

Total 38566

FY 2001 Planned Program

- 18819 - CKEM - Award contracts to mature the system design concepts and validate component technology.

  - CKEM - Perform detailed design and rebalancing as required to reflect the emerging results from the technology and component development effort. Define technical risk and develop a risk reduction plan; develop cost breakouts for elements; and develop objective/thresholds for key performance parameters in a Cost as an Independent Variable (CAIV) strategy.

  - CKEM - Perform system trades and assessments utilizing both 6-Degrees-of-Freedom and Force-on-Force models.

FY 2001 Planned Program (Continued)

- 6897 - High-G MEMS IMU - Perform research to mature sensor and electronic design, foundry processes, and testing at competing contractor facilities for advancement of affordable, high-G MEMS IMUs applicable to the requirements from both elements of the precision guided munition community: high-G from the gun community and high performance from the guided missile community. This is a cooperative Industry/Government program jointly managed by the gun and missile communities.
- 7443 - Missile guidance systems - Combine two single axis MEMS-based angular rate sensors to form a dual axis sensor; ground test in military environments; and mature a prototype MEMS-based roll rate sensor that meets the FCS inertial sensors design requirements. Use collected data in flight simulations and performance assessments for applicability of ATR to relevant weapon systems. Test infrared imaging counter-countermeasures.

  - High fidelity system level simulations and aerodynamics - Investigate infrared (IR) target signature models applicable to active IR target acquisition and tracking sensors. Devise methods and write software for representing 3-dimensional target geometry models applicable to active IR sensors where signal polarization may be a processing discriminant. Investigate methods of projecting hardware-in-the-loop (HWIL) in-band IR target images and scenes with adequate scene detail and dynamic range to include the effects of active and passive IR countermeasures. Complete and demonstrate the target verification monitor with application to all types of Ka-band pulse and continuous wave (CW) radiation in a HWIL simulation facility.

- 12398 - Smart, stealthy, smokeless missile propulsion and smart structures - Complete component maturation of flight type hardware and integrate into a brassboard. Test a flexible sustainer for long range, survivable, multi-mission capabilities. Complete vacuum aging study for service life prediction for cost avoidance of replacing propulsion systems and increased system safety and performance reliability. Devise methodology for aging assessment of gel propulsion systems.

  - Focused technology integration - Design a digital system manager (DSM) and integrate with the sensor suite to optimize power consumption, and finalize and validate limited failure models for RRAPDS. Complete design to provide real-time targeting for short/medium range indirect fire munitions using a miniature (45-60 centimeter wingspan) aerial vehicle. Select approach and complete bench test prototype hardware to adapt the DARPA Netfires Loitering Attack Munition (LAM) to rotary wing aircraft.
- 4433 - One year Congressional add to complete Low Cost Guidance and Navigation Unit fabrication of a prototype navigator including synchronous sampling, ultra-tightly coupled Global Positioning System/Inertial Measurement Unit (GPS/IMU), and full set of navigator functions able to meet Extended Range Gun Munition (ERGM) and XM982 155mm Extended Range Artillery Projectile form factors as well as those of larger missiles/vehicles.

- 1219 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 51209

FY 2002 Planned Program

- 10300 CKEM - Fabricate and test subsystems to define a basis for determining risk, achievable performance, and trade-offs between lethality/survivability and missile sizing.

  - CKEM - Perform hardware-in-the-loop simulation testing under flight representative conditions to assess and reduce risk. Achieve a Technology Readiness Level (TRL) of 5.

  - CKEM - Provide test results and assessments for the FCS Technology Readiness Decision in FY03.

- 10000 - High-G MEMS IMU - Perform detailed design and analysis of first generation devices, incorporating emerging results from development effort. Construct, evaluate, and refine manufacturability processes to begin production automation and process control maturation.

- 8815 - Missile guidance systems - Test a dual axis MEMS-based angular rate sensor (ARS) that incorporates technology developed by DARPA. Test in the laboratory and in a HWIL environment both the dual axis MEMS-based ARS and the single axis roll rate sensor. Design uncooled IR sensor for missile applications.

  - High fidelity system level simulations and aerodynamics - Investigate designs for signal generation applicable to HWIL simulation of IR LADAR devices. Implement improved techniques for PC-based massively parallel computation of target RF signatures. Design and build databases of RF and IR target signatures suitable for multispectral HWIL simulation.

- 3732 - Smart, stealthy, smokeless missile propulsion and smart structures - Complete design, fabricate and test brassboard of a deep throttling booster that extends the capabilities of controllable thrust technology to increase range and provide multi-mission capability for a family of FCS and Objective Force weapon systems.

- 7265 - Focused technology integration - Integrate a "full-up" RRAPDS system sized TOW Fire and Forget missile which will have applicability to all tactical missiles to include CKEM, Common Missile, LAM, and LAM-A. Evaluate RRAPDS as an HTI candidate for a launch platform and a high value conventional munition. Evaluate ability to provide the user with target information on stationary and moving military vehicles using small unmanned aerial vehicles.

Total 40112

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June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - APPLIED RESEARCH	**0602303A - Missile Technology**	**223**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
223 AERO-PROPULSION TECHNOLOGY	12409	18867	0	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This Congressionally directed project focuses on missile and rocket aero-propulsion technologies. It develops aerodynamics and related propulsion technologies and demonstrates enhanced range, maneuverability, and the survivability for missiles and UAVs. It explores unique aerodynamic characteristics and propulsion concepts to enhance missile flight performance at subsonic, supersonic, and hypersonic velocities. Current efforts include: scramjet, aero-optic evaluation facility, and computational fluid dynamics.

FY 2000 Accomplishments

- 1909 - Scramjet - tested a Scramjet missile propulsion concept in a ground test facility operating at full scale and at duplicated flight conditions.

  - Provided Scramjet hardware for testing, analytical performance predictions, and data reduction and analysis.
- 2864 - Aero-Optic Evaluation Facility - Tested hypersonic missiles in a ground test facility operating at full scale and at duplicated flight conditions
- 7636 - Computational Fluid Dynamics (CFD) - developed a specialized computer system for designing and developing missiles and missile components using CFD.

Total 12409

FY 2001 Planned Program

- 3500 - Aero-Optics Evaluation Center (AOEC) - provide for upgrade of testing equipment and facilities for various endo-atmospheric missile systems. These tests will provide critical aero-optical, aero-thermal, aero-acoustics, and aerodynamic data prior to flight testing.
- 1500 - Enhanced Scramjet Mixing - provide for development and testing of concepts to enhance the mixing of the fuel/air streams of a supersonic combustion scramjet engine
- 8000 - Accelerated Development/Test of Tactical Missile Components - provide for development and testing of advanced technology components that can be integrated into future tactical missiles concepts.

FY 2001 Planned Program (Continued)

- 6000 - Future Army Tactical Missile Integration Program - Provide integrated solutions through analysis and tests of multiple integrated advanced technology components that must operate in an environment that includes aero-interaction with the guidance, propulsion, and/or missile air frame.

Total 19000

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June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - APPLIED RESEARCH	**0602303A - Missile Technology**	**340**

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
340 SWORD	2456	0	0	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: Over the past 10 years the US Army Ballistic Missile Defense Organization has been investigating the use of interferometry to develop a highly accurate radar system to use in defense of high value assets. The current SWORD concept uses this technology to support the counter air munitions defense mission and provide protection from saturation or simultaneous attack from ballistic rockets or artillery. The accuracy of the radar allow for removal of an interceptor seeker, therefore, reducing the cost of the overall system. Potential technical issues for this system concept were identified by the Deputy Assistant Secretary of the Army for Research and Technology (DAS(R&T)), who sponsored a SWORD Independent Review Team (IRT) effort. The SWORD Radar S&T Program addresses these issues by determining the magnitude of system and operational errors and developing mitigation techniques to reduce these errors to the operational requirement levels. This SWORD S&T Program has been endorsed by Office of the Secretary of Defense. If the SWORD Radar S&T effort is a success, the Army will evaluate the potential of a SWORD ATD. The work in this program is consistent with the Army spectrum of operations in the Chief of Staff, Army vision: deployable, agile, versatile, and lethal. Work is performed by SMDC, Huntsville, AL. Contracts have been awarded to Technovative Applications, Brea CA; Georgia Tech Research Institute, Atlanta GA; Amtec, Huntsville AL; and Delta Research, Huntsville AL.

FY 2000 Accomplishments

- 2446 The SWORD Science and Technology Program executed the Bench Test in FY00 that addressed wide bandwidth target spectral distortion and range gate straddle error sources. The SWORD Radar S&T Program has completed its first major milestone. Dr. Stotts, Director of Technology for the DAS(R&T), was briefed on the Bench Test results, High Fidelity Simulation Planning efforts, and the Single Channel Wide Band Receiver design. The Bench Test results came to the following conclusions: theory, simulation, and the bench test reveal that Target Spectral Distortion and Range Gate Straddle errors can be successfully mitigated to acceptable error levels by using short sample interpolation intervals at relative locations in the matched filter.

Total 2446

FY 2001 Planned Program

Project not funded in FY 2001.

FY 2002 Planned Program

Project not funded in FY 2002.